DLN Retrofit in Two Frame 7 Gas Turbines
RasGas LNG Company-Qatar

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Contents

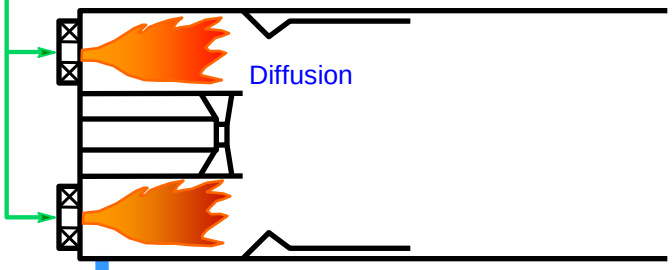
Summary of the project

- Regulations set by Ministry of Environment to achieve NOx emissions of 25 ppm for such turbines.
- Two retrofitted units are driving Mixed refrigerant and propane in the LNG refrigeration cycle.
- Project engineered in years 2009-2010 and implementation done in year 2011 successfully.
- 1st successful DLN retrofit for Frame 7EA Gas Turbines in an LNG train.

DLN1 Fuel Staging & Operational Modes

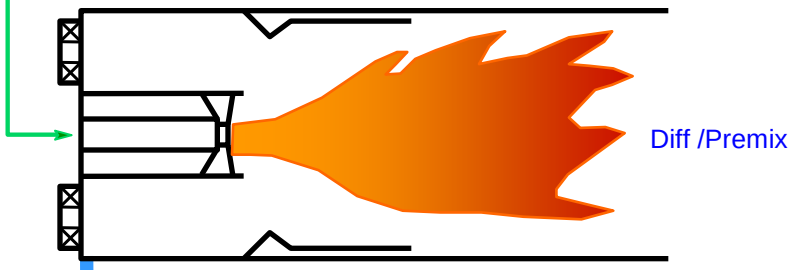
Primary Mode

Diffusion Flame
100% Primary Fuel
Ignition - 19% Load



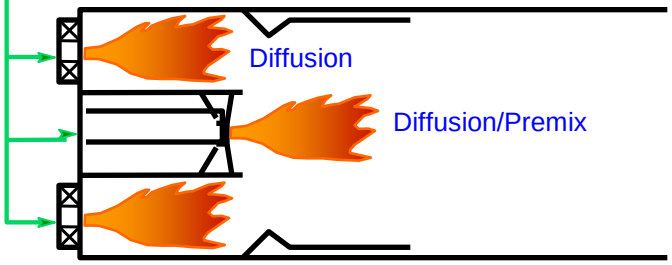
Transfer Mode

Diffusion Flame
100% Secondary Fuel
50% Load



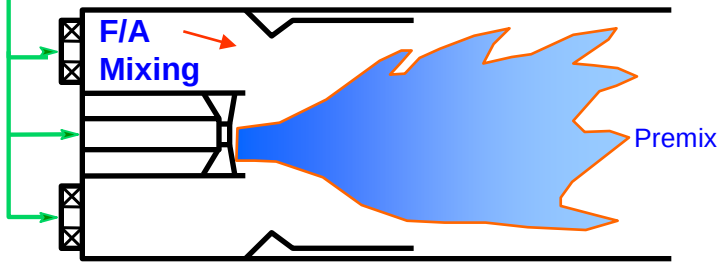
Lean-Lean Mode

Diffusion Flame
~60% Primary / 40% Secondary Fuel
19% - 50% Load



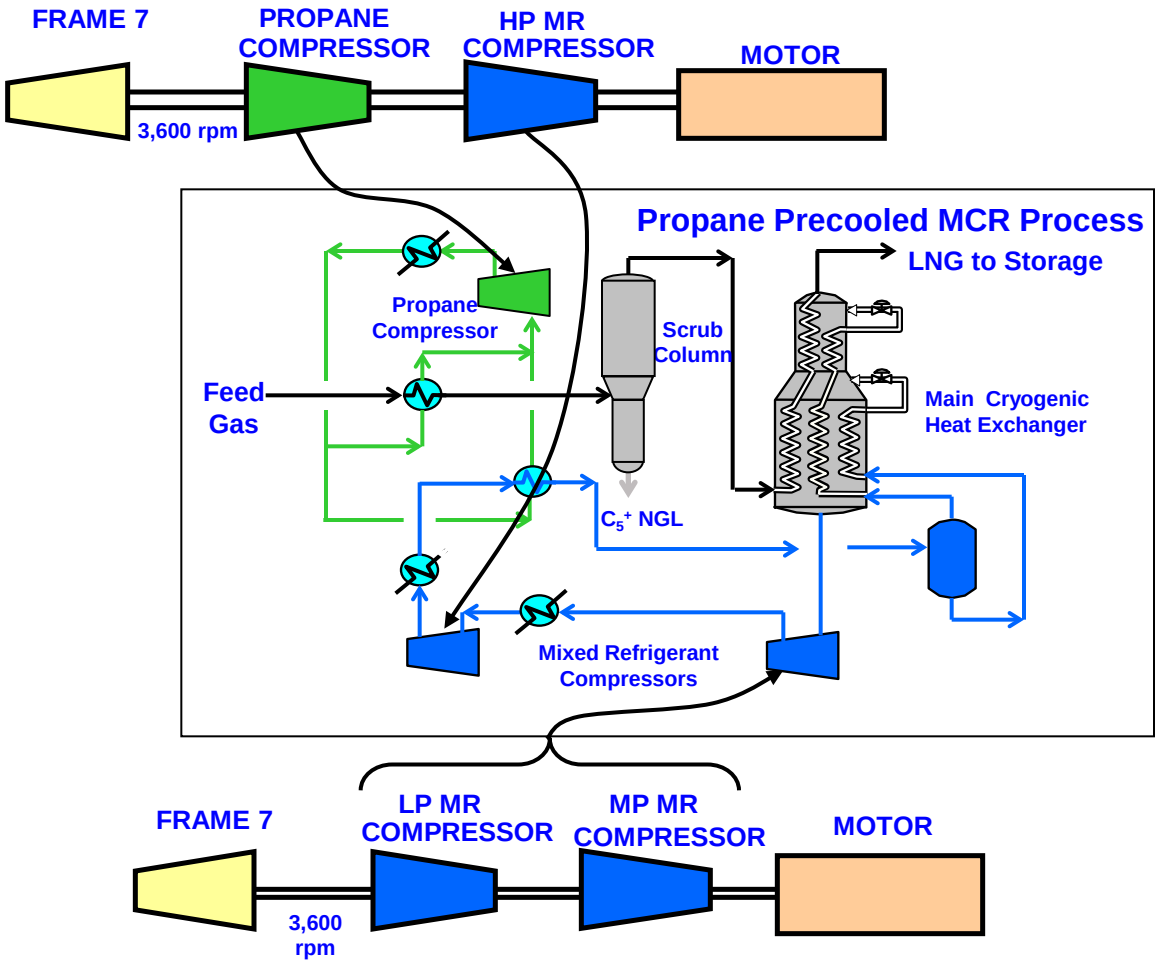
Premixed Mode

Premixed Flame / Diffusion Pilot
81% Primary / 19% Secondary Fuel
50% - 100% Load For IBH machines
or 80%-100% Load for machines without IBH

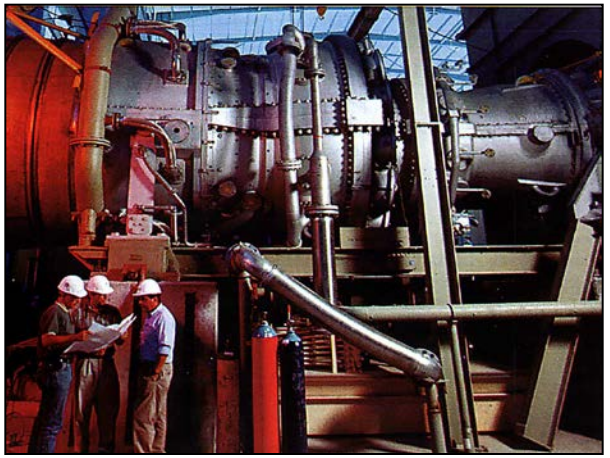


Primary Zone Dual Purpose: 1. Low Load Diffusion Flame 2. High Load Premixing Chamber

Process Compressors for RasGas Train 3



Frame 7 Gas Turbine



Requirements for DLN retrofit

- Stable fuel gas supply pressure
- Rate of change of MWI
- Contaminant free fuel gas
- Turbine Control logic upgrades for mechanical drive application

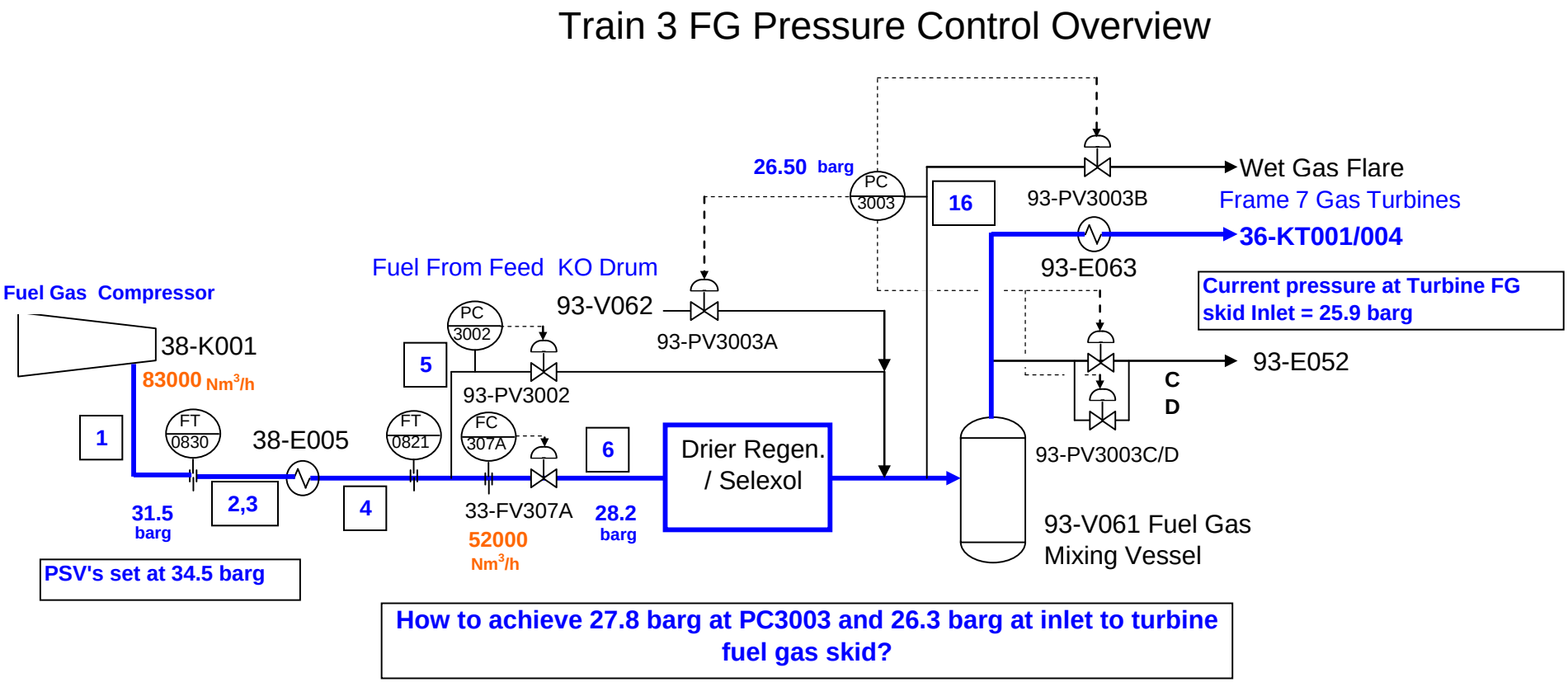
Requirements for DLN retrofit

Fuel Gas Pressure

Adequate & stable fuel gas supply pressure

- Increase the fuel gas supply network pressure
- Fuel Gas Pressure Control Ramp Up Logic :
  - Considers scenarios of fuel compressor trip or upset
  - Ensures fast make-up from back-up sources of fuel gas i.e. Fuel From Feed (FFF) or Boil Off Gas (BOG) to sustain the minimum fuel gas supply pressure

Train-3 Fuel Gas Supply System



Requirements for DLN retrofit

Fuel Gas Quality

Limited changes in the fuel gas Modified Wobbe Index (MWI):

- Resized the Fuel gas mix drum to meet max. MWI rate of change of 0.3%/sec from existing of 0.5%/sec.
- The **new fuel gas mixing drum** is around 25% bigger in volume to meet the rate of change of MWI as above

Requirements for DLN retrofit

Fuel Gas Contaminants

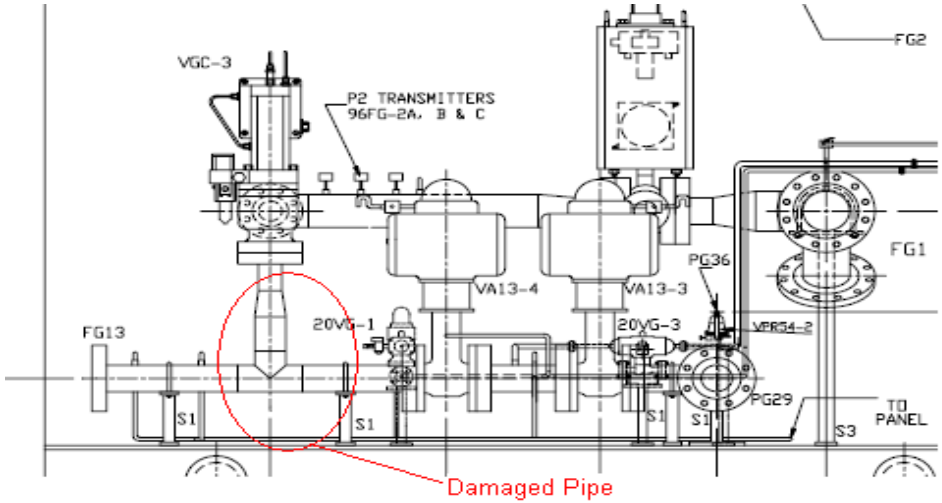
- Meets OEM spec for fuel gas in terms of maximum allowable contaminants.
- LL from existing train indicates presence of Selexol can act as an ignition source & cause fire in fuel gas piping at valve skid in event of passing purge valves.
- Additional requirements resulted in upgrades in the fuel gas system as follows:
  - Upgraded fuel gas filter skid to meet specs for liquid carry over & particulate size.
  - Upgraded demisters for upstream fuel gas treatment column & KO drum.
  - Provision of demister in the fuel gas mixing drum.
  - Low point drains.
  - Modified fuel gas skid with piping layout to prevent Selexol accumulation.

Requirements for DLN retrofit

Contaminants Free Fuel Gas

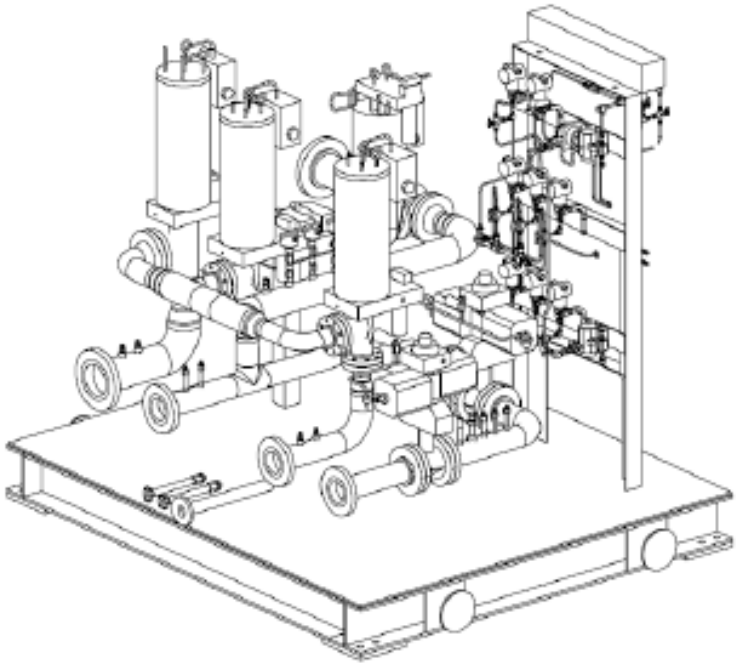
Lessons learned from another train:

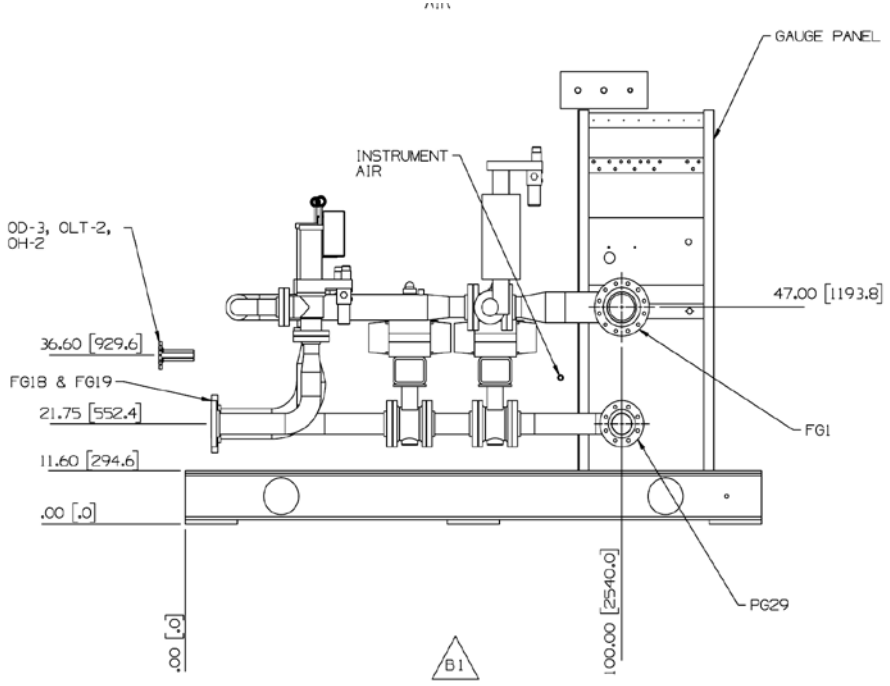
- Selexol carry over for fuel system
- Auto ignition of accumulated Selexol in presence of hot air from axial compressor discharge
- No combustion dynamics' monitoring



Requirements for DLN retrofit

New Fuel Gas Valve Skid

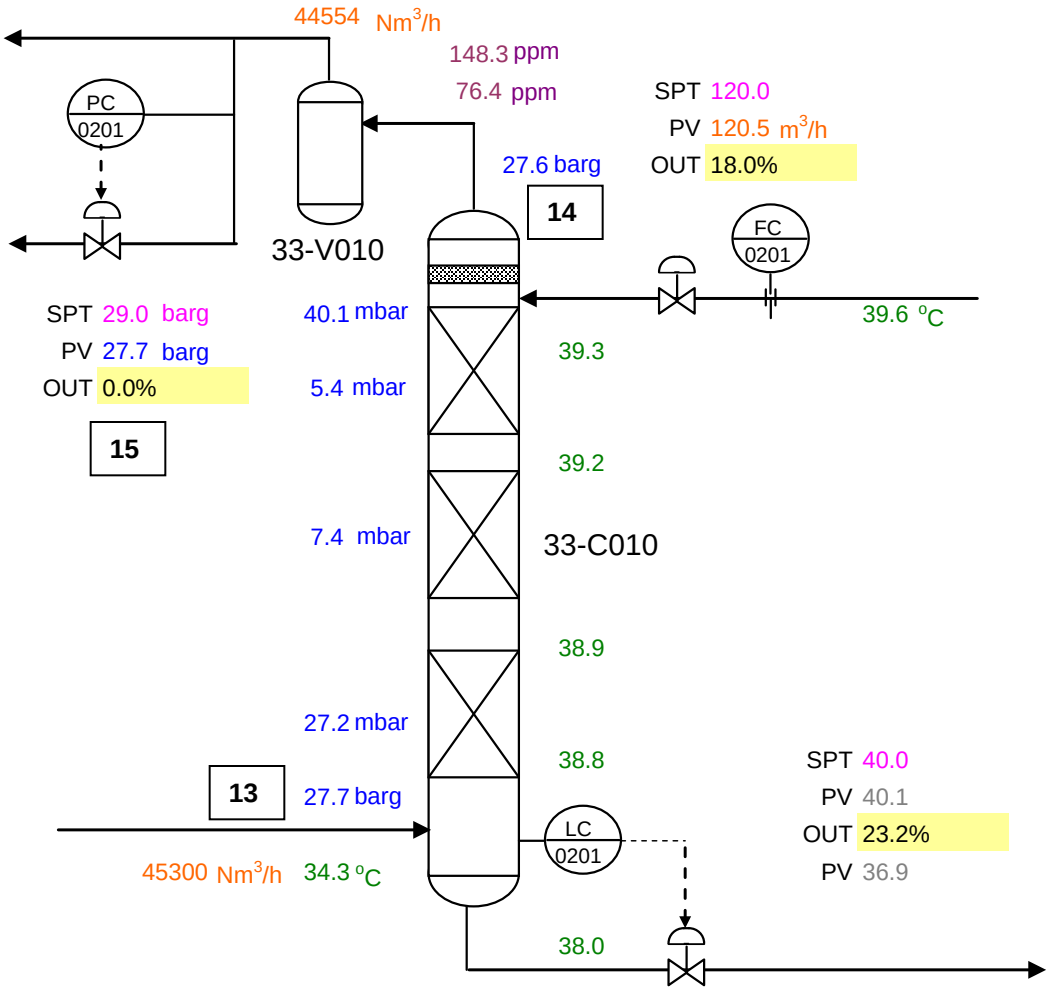




Train-3 Fuel Gas treatment unit

Demister upgrades

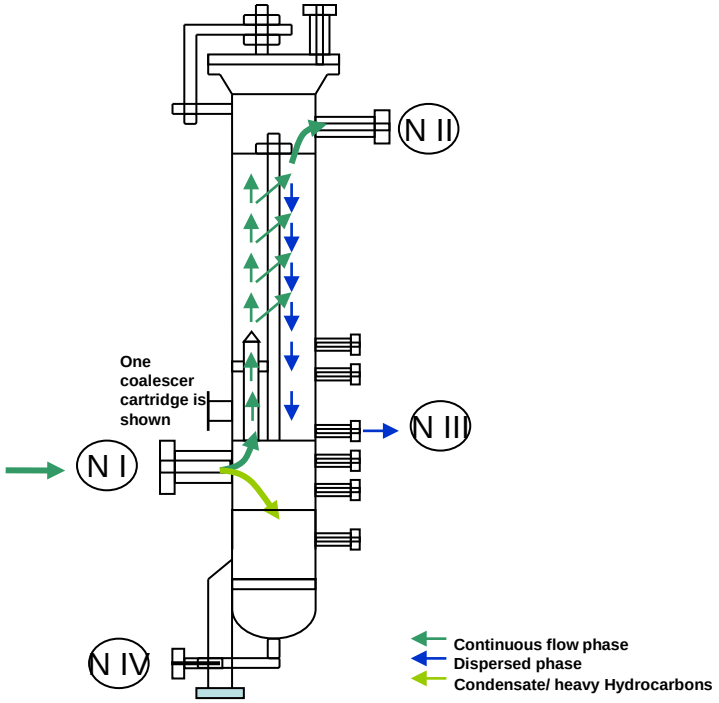
Demisters upgrade for
Selexol Absorber 33-C010 &
Fuel gas KO drum 33-V010



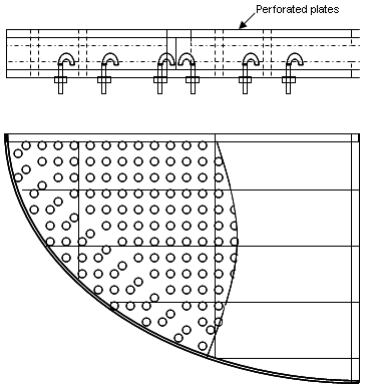
Requirements for DLN retrofit

New Fuel Gas Filter Skid

- Filter elements are suitable for maximum operating temperatures 82°C.
- Cartridges elements, made of CS604LGBH1 which is a amine compatible element working as coalescer element.



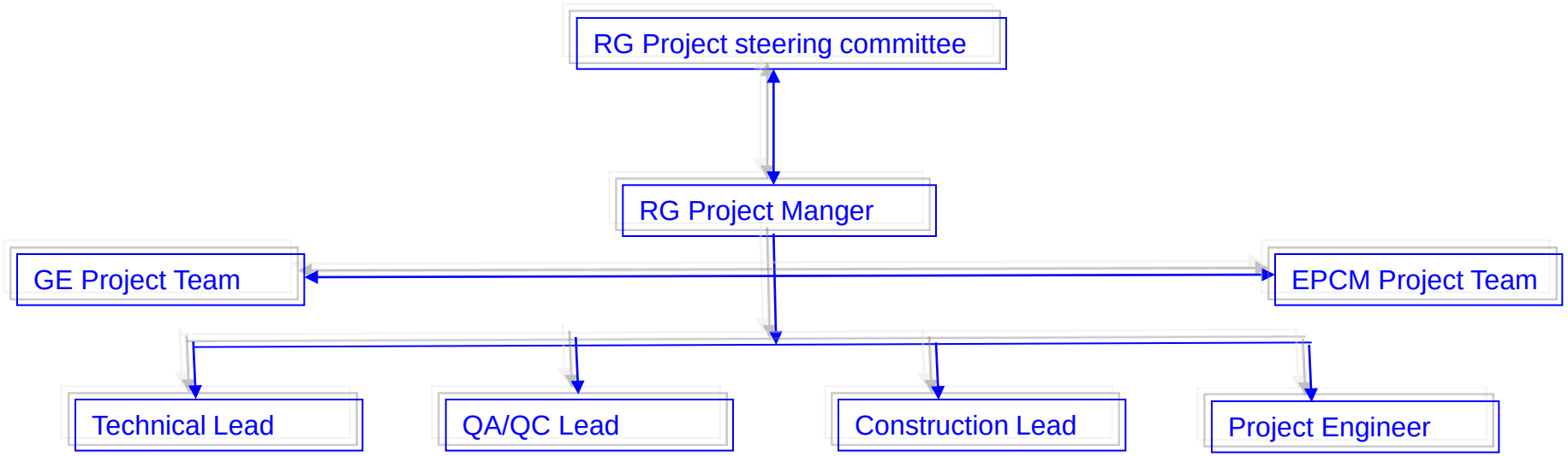
New demister tray inside mix drum



Milestones

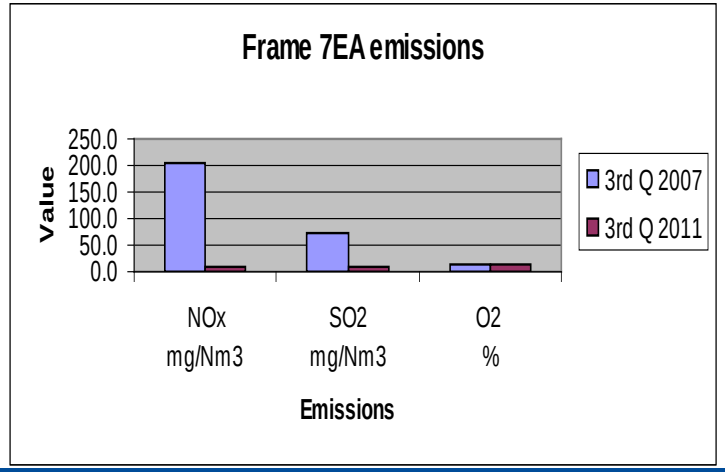
- **Gate-1 / 2:**
  - Scope, strategy development, feasibility-technical & economic
  - Pre-Feed & management approval: Aug'09.
- **Gate-3:**
  - What if Analysis: Aug '10.
  - CDRA: Sep'10.
  - HAZOP: Oct'10
  - Cold Eye Review : Nov'10.
- **Gate-4:**
  - Constructability Readiness Review : Feb'11
  - Detailed Engineering completion & construction readiness: March'11
- **Gate-5:** Construction, commissioning & start-up:June'11
- **Gate-6:** Close out: & LL: Oct'11

Project Organization



Project Details & Results

- Engineering man hours : 30,000 approx.
- Construction Man hours: 90,000 approx.
- Excellent safety records during construction.
- Construction and commissioning meet the plan schedules.
- Both turbines successfully re-commissioned post DLN retrofit
- Achieved NOx emission reduction:



Challenges & Lessons Learnt

- Limited train shutdown duration of 22 days (Mechanical)
- Incorporate lessons learned from other frame 7EA DLN machines result in increase LNG train reliability:
  - Fuel gas contaminant control measures (Filters, demisters, etc)
  - Ramp-up logic for stable fuel gas supply pressure
  - Additional scope for reliability improvement : Combustion Dynamic monitoring system
- Job Clash: Simultaneous construction with other activities during shutdown (Compressor overhaul, turbine major inspection and heavy lifting activities)
- Interface management with multiple parties
- Technical & project management issues
- Brown field application : Requirements of Smooth startup without production impact.

Thank you